GEOLOCATION METHOD AND APPARATUS FOR SATELLITE BASED TELECOMMUNICATIONS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application relates to co-pending application "GEOLOCATION METHOD AND APPARATUS FOR SATELLITE BASED TELECOMMUNICATION SYSTEM", filed Apr. 24, 1996, Ser. No. 08/638,066, Attorney Docket No. 16-0281. The above co-identified application, 08/638,066, is assigned to the Assignee of the present application and expressly incorporated herein in its entirety by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable

BACKGROUND OF THE INVENTION

The present invention generally relates to a satellite based telecommunications system. More specifically, the invention relates to a method and apparatus for calculating the geolocation of user terminals based on information within the communications signal.

Today satellite systems exist for supporting telecommunications with, and/or providing geolocation information to, user units. Satellite based telecommunications systems, such as Odyssey (as proposed by the assignee of the present application), utilize a constellation of satellites to relay communications signals between user terminals and earth or base stations. The user terminals are assigned to earth stations. The earth stations direct calls to and from the assigned user terminals. The user terminals and associated earth stations communicate along preassigned communications channels having a preassigned bandwidth (subband) centered about a carrier frequency. Some communications systems may require that the location of a mobile terminal communicating through the satellite constellation be determined or verified for a number of reasons, such as to efficiently allocate network resources, to block or accept services based on mobile terminal location, to route calls to special bureaus for emergency or operator services, to effect billing dependent upon location, to direct emergency services, to provide secondary navigational services and the like. Heretofore, the location of mobile terminals may be determined by a satellite based navigation system.

Satellite based navigation systems, such as the global positioning satellite (GPS) system, include a constellation of satellites which transmit navigation signals to the user units. Each satellite emits a unique navigation signal along a preassigned navigation channel. User units obtain navigation information from multiple navigation signals and, based thereon, calculate the terminal's position relative to the earth. One GPS technique is explained in an article entitled "*GPS Signal Structure and Performance Characteristics.*" by J. J. Spilker, Jr., Global Positioning System, which is incorporated by reference in its entirety. However, in GPS systems, a navigation terminal requires the use of navigation measurements from at least three satellites and only affords one way communications. The GPS navigation terminals do not transmit signals to the satellites.

Alternatively, ranging systems have been suggested for tracking moving satellites from earth stations. One example is the TDRS system which performs ranging of moving satellites from a geostationary satellite. The TDRS system relies on a single two-way ranging link between a geosynchronous satellite and a low orbiting satellite to track movement of the low orbiting satellite. Alternative ranging systems use a single two-way ranging link between an earth station and a satellite to track movement of the satellite. However, these ranging systems require ranging measurements to be made over a long period of time in order to ensure high accuracy and resolve position ambiguity of the moving satellite. Additionally, these ranging systems use only a single tracking station or track a single satellite at any given time. Further, these ranging systems have not been applied to position determination of mobile terrestrial user terminals.

Further, the navigation, ranging and communications signals are transmitted over separate, mutually exclusive channels specifically designated to carry corresponding signals. Consequently earth stations, satellites and user terminals must be designed to support separate communications and navigation channels, thereby undesirably complicating the overall system. Existing telecommunications systems have not been able to merge communications and geolocation signals/data onto a single RF signal. Instead, conventional systems rely on radio signals and associated transmitters and receivers which are specifically designed and applied for position determination.

As the popularity of cellular telecommunications increases, more and more demands are being placed upon the capacity of telecommunications satellite systems. These demands effectively monopolize the available communications subbands. Satellite systems have attempted to increase the overall capacity of the available frequency subbands by utilizing a variety of user-access or "spread spectrum-based" techniques to increase the user-density within a given frequency subband. These user-access techniques include frequency division multiple access (FDMA coding), time division multiple access (TDMA coding), and code division multiple access (CDMA coding). In addition, hybrid techniques have been proposed using a combination of TDMA, FDMA and CDMA codes. Depending upon the coding technique, each user terminal when assigned to a corresponding channel, is given a unique TDMA/FDMA/CDMA code and/or transmission timing/frequency. The user terminals transmit and receive all communications signals at the assigned carrier channel, code and transmission timing/frequency.

As the coding techniques increase the user density, acceptable tolerances decrease between adjacent user channels before co-channel interference results. Therefore, the above-mentioned coding techniques require the communications link between a user terminal and an earth station to be adjusted or tuned continually. Such adjustments are necessary to ensure that the user terminal continues to transmit within its assigned channel as the user terminal and/or coverage satellites move relative to one another.

User terminals and earth stations transmit telecommunications signals as discrete packets or frames of information. Several of the above-mentioned coding techniques require that the communications link be maintained "synchronous" between the earth station and the user terminal. A "synchronous" communications link requires that each frame of data be received (at a user terminal or an earth station) at an instant in time simultaneous with receipt of frames transmitted from other terminals and/or earth stations. The frames must also be received in the assigned subband centered about an assigned carrier frequency. Thus, synchronization and subband alignment are determined with respect to the receiver.